Application of DSS to Study Wind Generation for Manitoba Hydro

Bill Girling
Manitoba Hydro

Diana Hurdowar
Stuart Bridgeman
Synexus Global

Outline

- Wind Power in Manitoba
- Wind Integration issues
- Short-Term Wind Uncertainty and Variability
- Short-Term Model- *'Vista'* DSS Tool
- Application of *Vista* to Wind Integration

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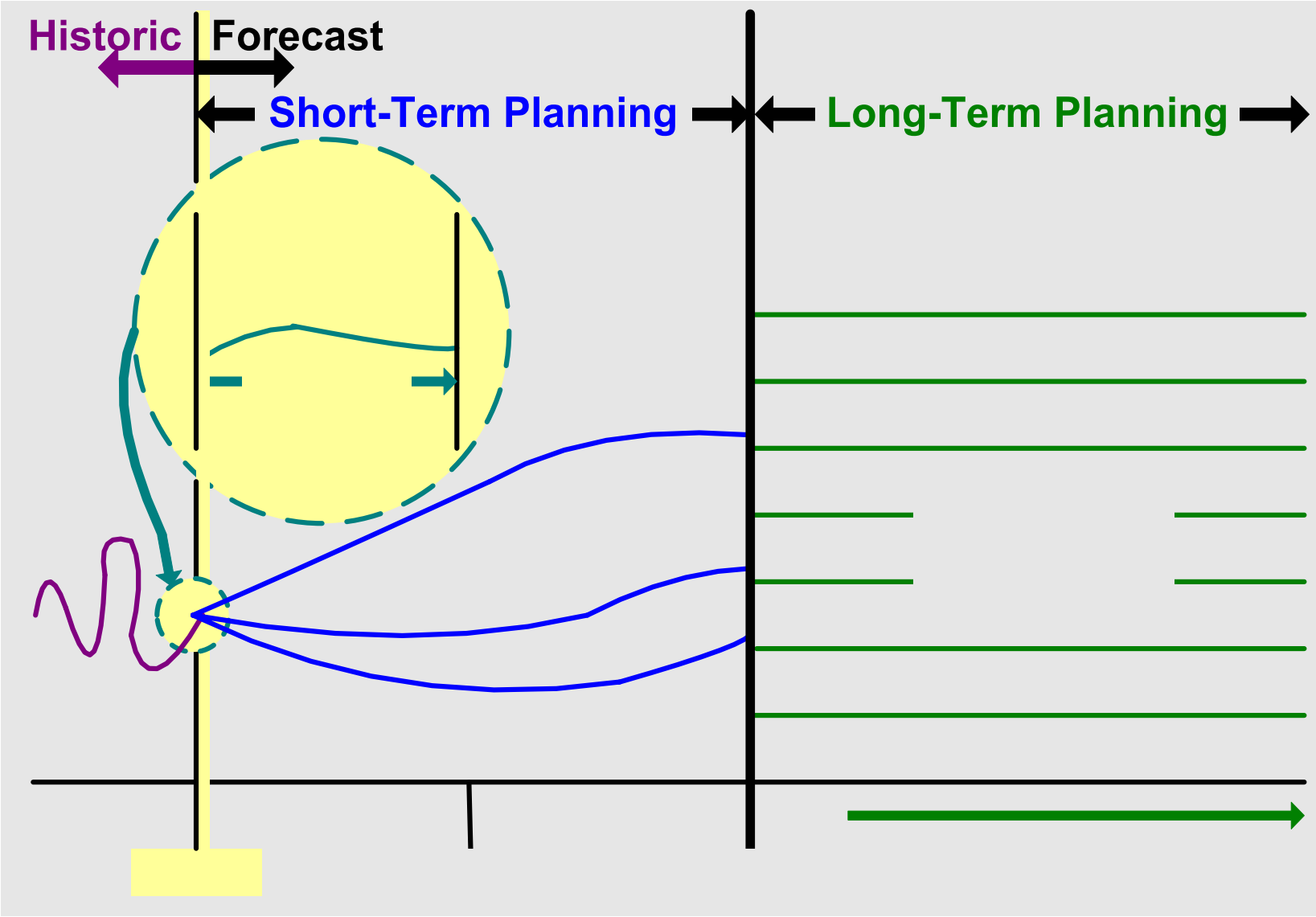
Planning Horizons & Inflow Forecasts



Why is Manitoba Hydro studying Wind Power?

- Manitoba does not require new generation for domestic load until around 2020 but wind power can be exported.
- Another source of power during drought periods when thermal is needed.
- Can be put into service in 1 to 2 years.

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Integrating Wind and Hydro

- Manitoba Hydro operates a hydropower system with large reservoirs capable of storing wind energy and shifting it to more valuable periods.

- Integrating wind with hydro operations can create a product with high value on export market.
- Need to know value of wind power to Manitoba Hydro's system in order to determine purchase price from independent wind developers.

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Integrating Wind and Hydro

The ability to get wind power to the market is dependent on flow conditions:

- Low Flow
  - Reduced import (on-peak & off-peak)
  - Reduced operation of thermal
  - Increased firm export opportunities
- Moderate Flow
  - Increased export opportunities to the limit of installed generation or tie-line
- High Flow
  - Virtually no value

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Wind Power Integration Issues

- Wind is inherently variable, it can neither be dispatched nor scheduled accurately
- Sub-optimal hydro operations due to short-term variability and uncertainty of wind generation
- Increased reserves for wind

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Modelling Framework

Types of Wind Integration Costs in Different Time Horizons

	Transmission Service Costs	**Generation Service Costs**	
	Regulation, Load Following & TRM Impacts	Impacts on Short Term Operations	Impacts on Longer Term Operations
	e.g. Need more generation on AGC	e.g. Reduced S.T. operating flexibility to accommodate wind uncertainty	e.g. Increased spill when system can't absorb more energy
	Electrotek	Model with VISTA ST/ MOST	Model with SPLASH
Time Horizon	Next Hour	Next Day / Next Week	Next Month / Next Year

SPLASH Model

- SPLASH models the system monthly operations for a 35 year period, using 86 years of flow history.
- SPLASH used to predict changes in monthly & seasonal hydraulic operations due to addition of wind
- SPLASH cannot address some of the short-term operating costs associated with wind energy, such as:
  - Cost of increased operating reserves
  - Regulation and Load-following
  - Operational inefficiencies due to the uncertainty of wind generation

Short Term Modelling Issues

1. Evaluate sub-optimal hydro operations due to short-term variability and uncertainty of wind generation
2. Evaluate lost opportunity cost from increased capacity reserve requirement for wind

- Regulation reserve for uncorrelated minute to minute variations in net load (on AGC control)
- Load following reserve for sub-hourly ramp in net load and next hour forecast error (idle capacity reservation)

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Vista used to Study Short-term Operational Aspects of Wind

- Short-term hydro operations planning tool used to compare economics of paired cases

Synexus Global will now describe the short-term model (Vista) used to Study Short-term Operational Aspects of Wind

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The Short Term Model
Vista DSS Suite

- Suite of programs developed under the Hatch-Acres umbrella within Synexus Global.
- An operations model used by dispatchers to schedule generation in a manner that maximizes revenue.
- ST (hour to week) -- LT (week to year) – AUTO (Planning)

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"*Vista*" Analysis Tool

A DSS is an computer tool that uses

- Forecasting
- Optimization and Simulation

to find cost effective solutions for :

- Long term energy management
- Short term scheduling

Operations

- Facility upgrading
- Strategic Planning
- Water Management Planning

Studies

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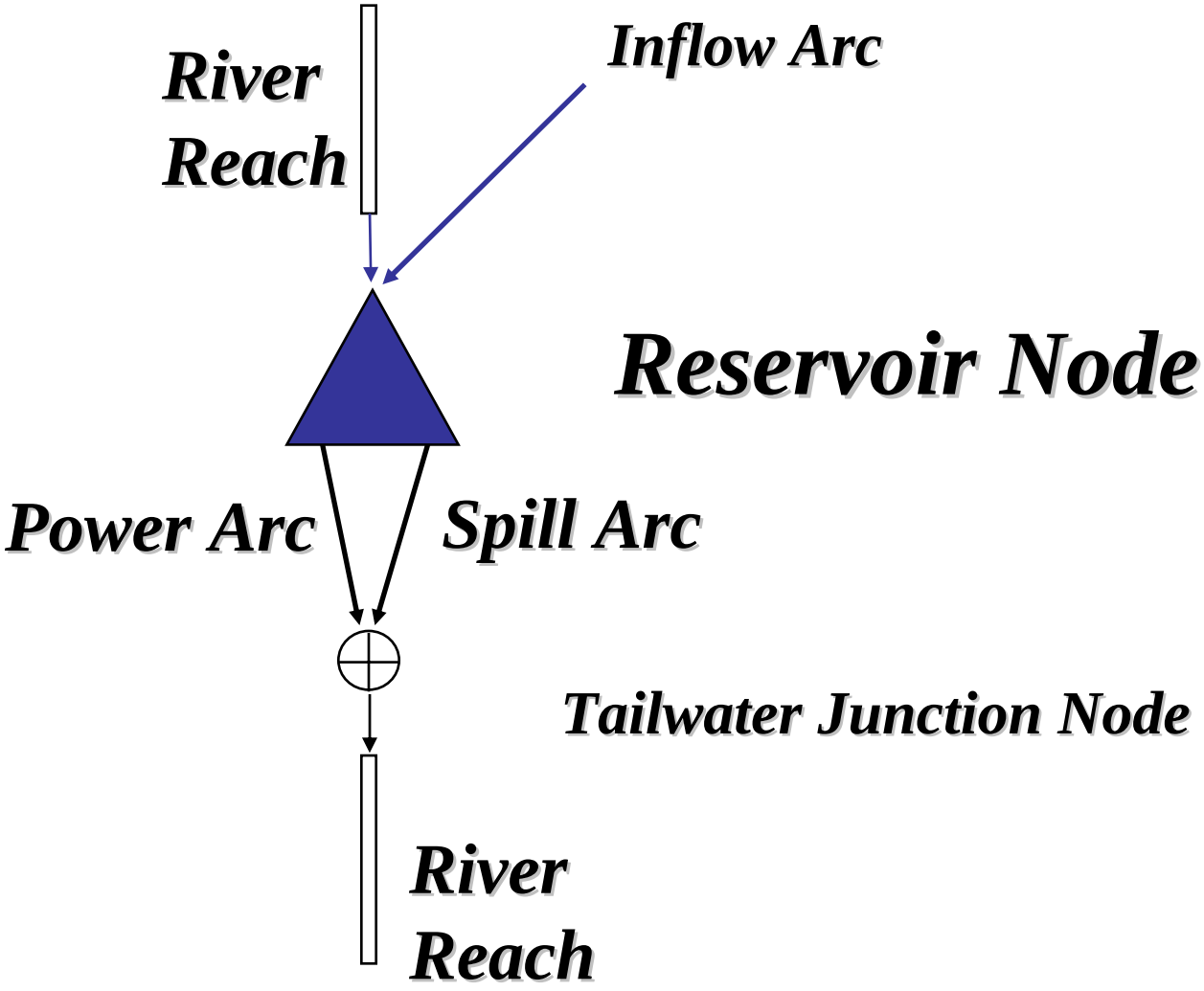
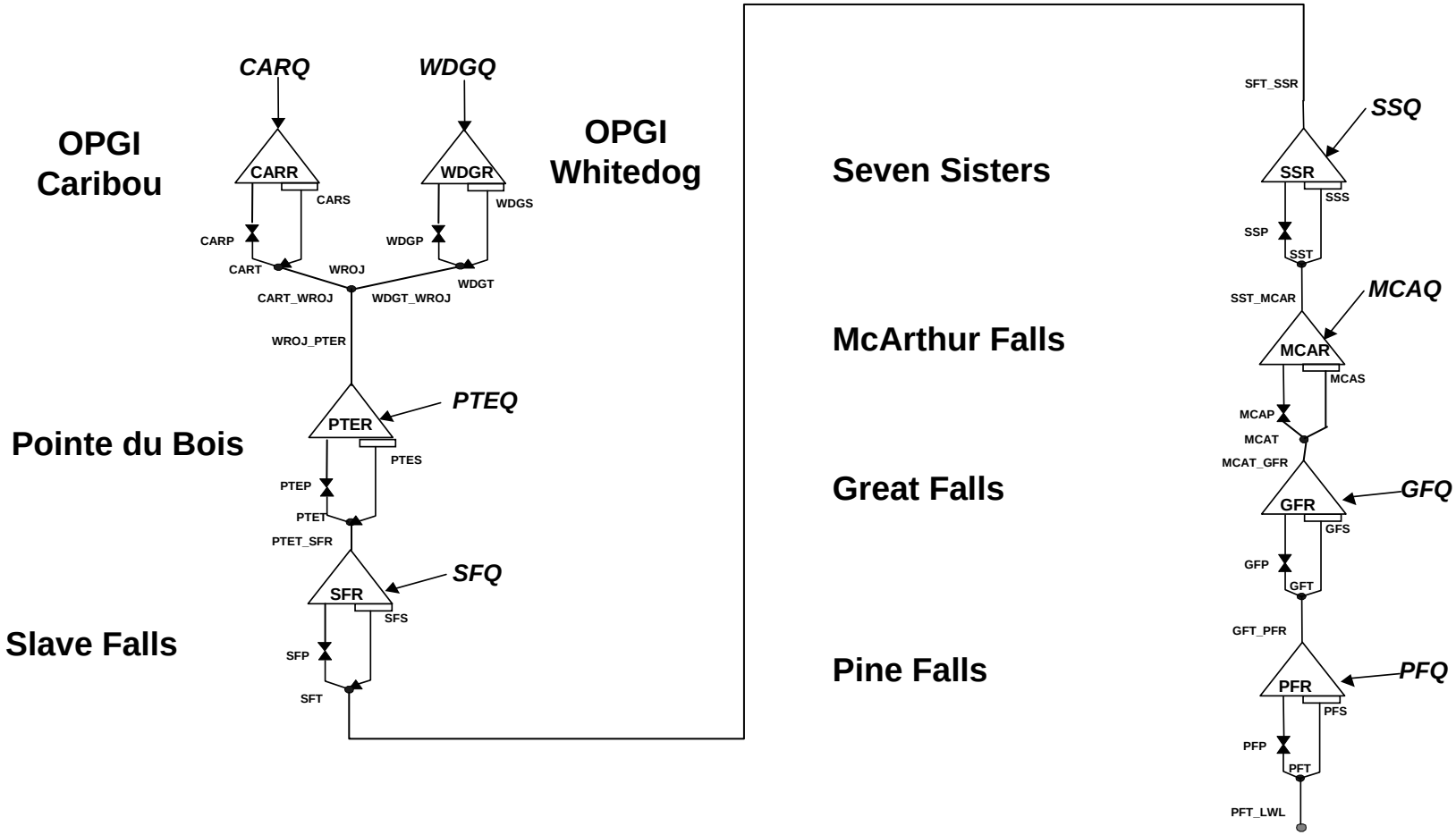
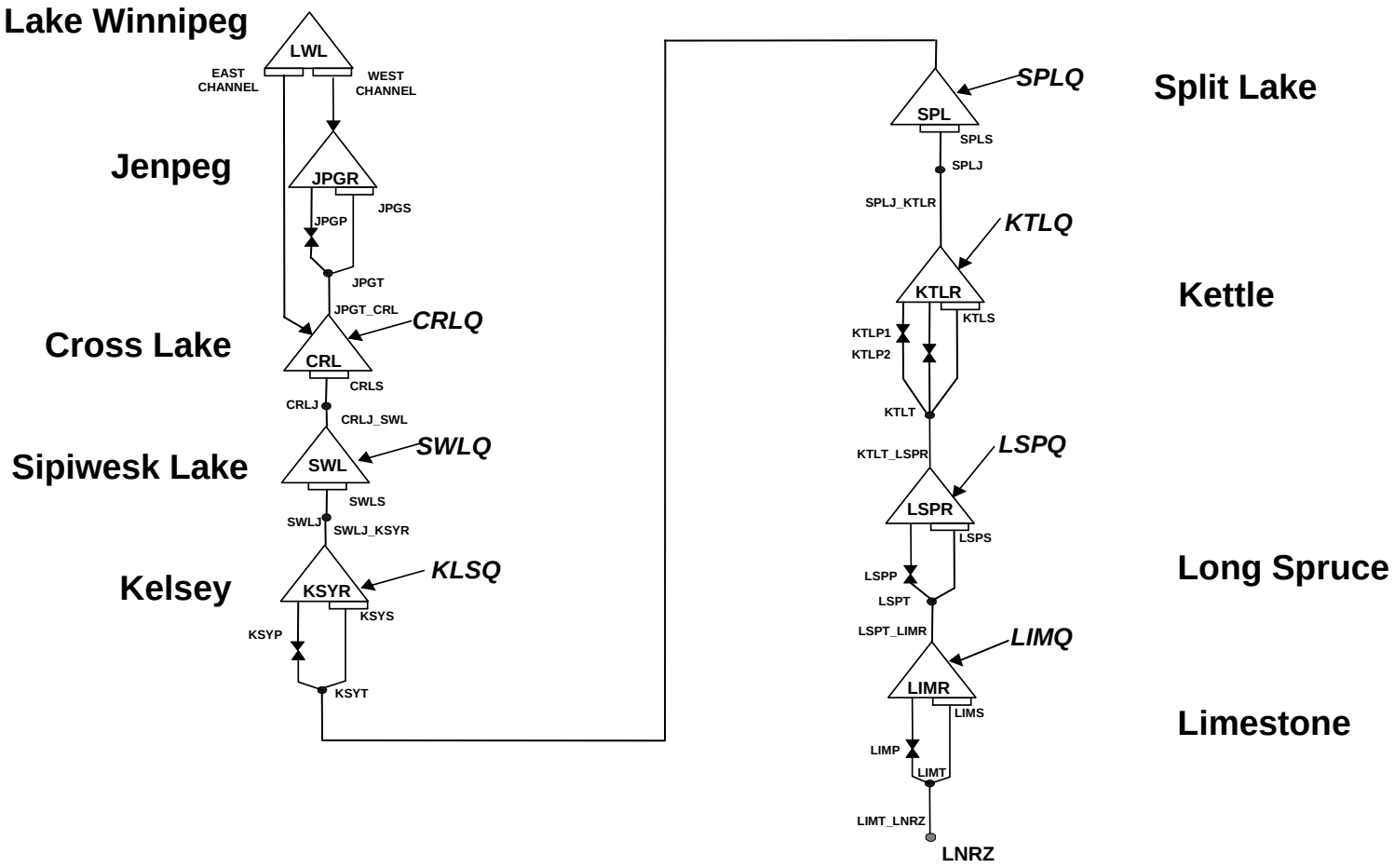
Vista Hydro System Components



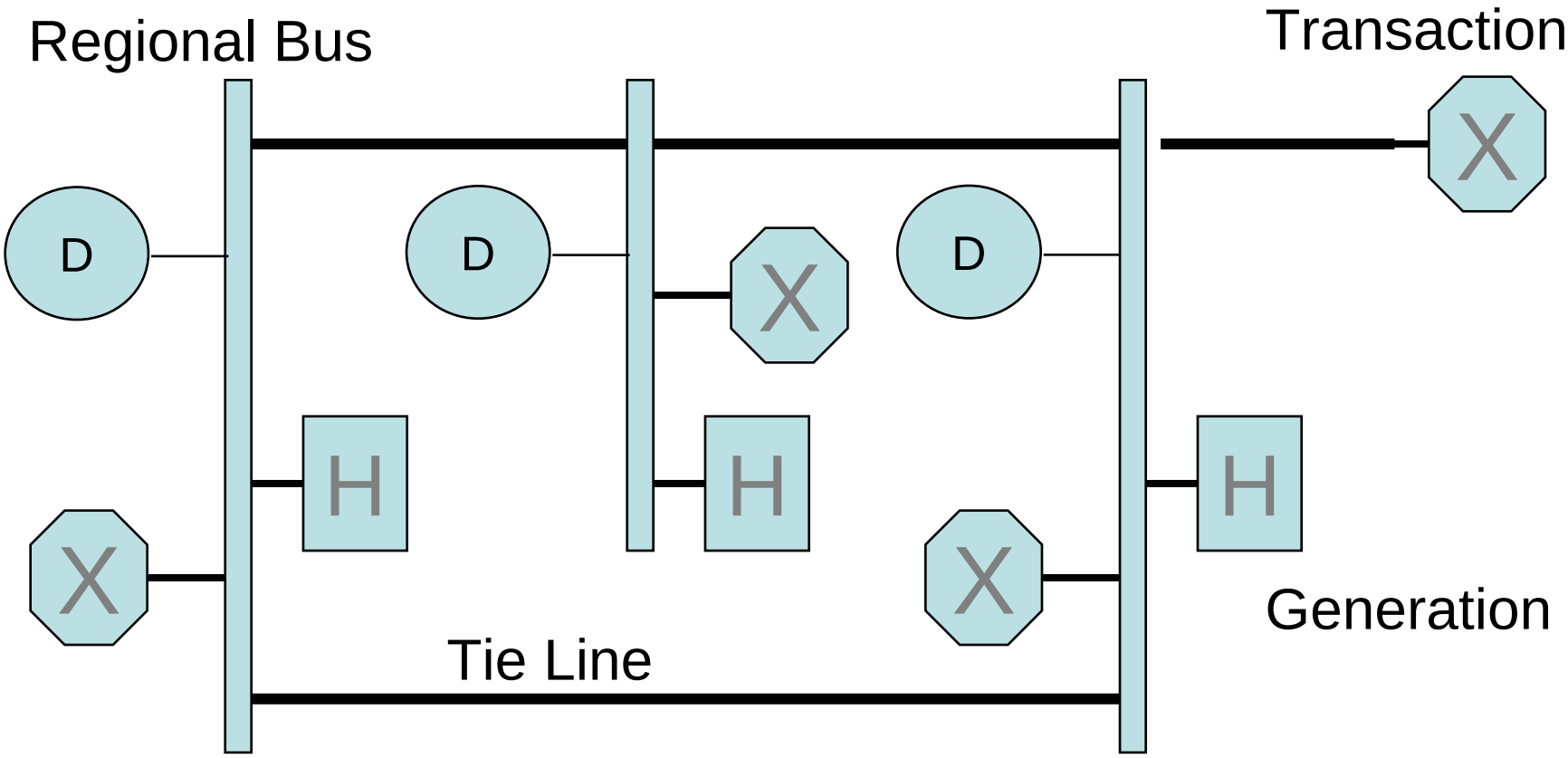
Winnipeg River



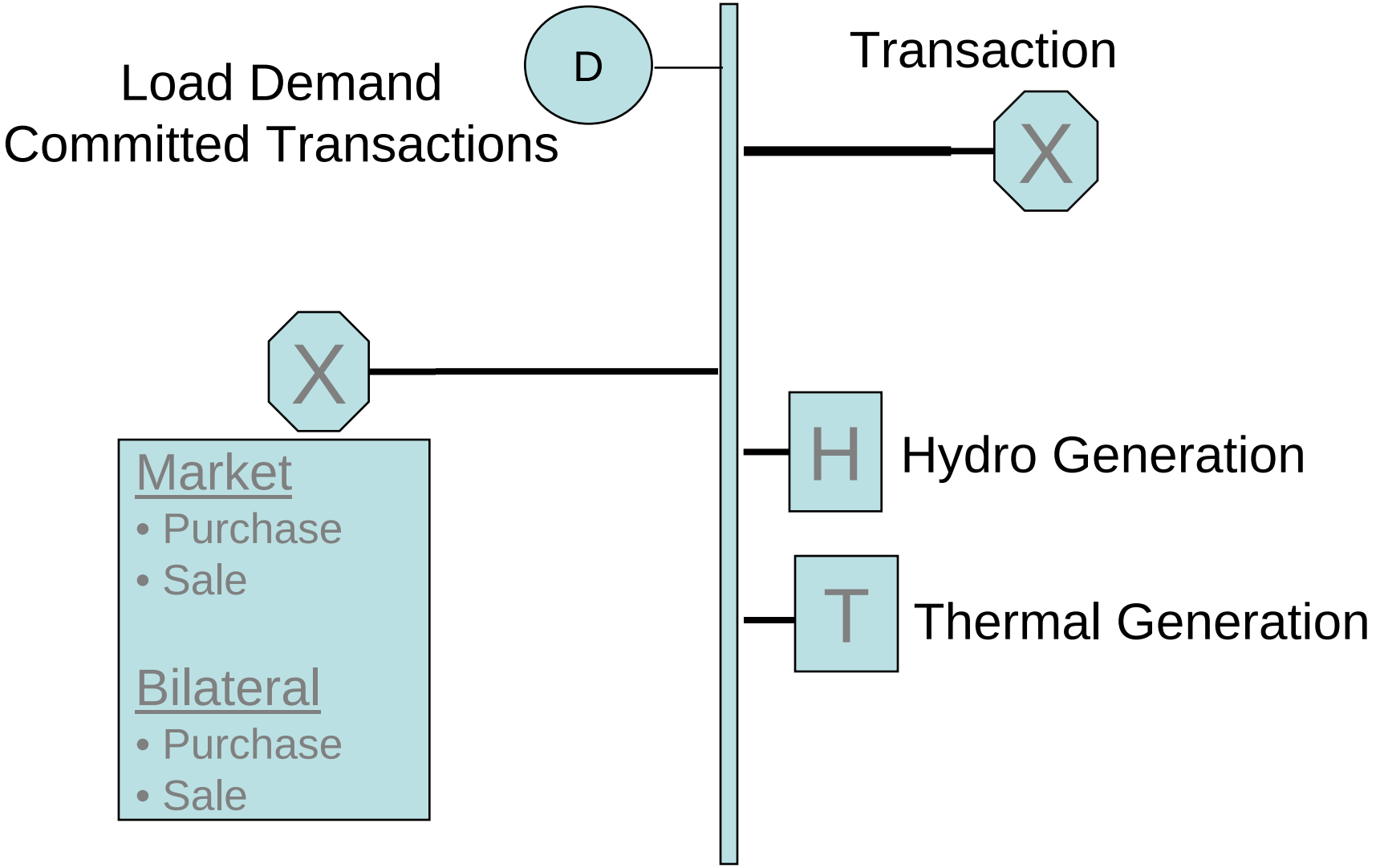
Nelson River



Vista Transmission System Components



Vista Transmission Area



Vista Workings

- Model workings
  - Physical/hydraulic/transmission characteristics and constraints
  - Market Price forecasts
  - Firm Contracts
  - Historical/forecast Inflow sequences
  - Load demands
  - Within-plant dispatch (Unit Operations)
  - Transaction opportunities
  - Reserves
- AUTO *Vista*
  - Performs analysis over 1 year

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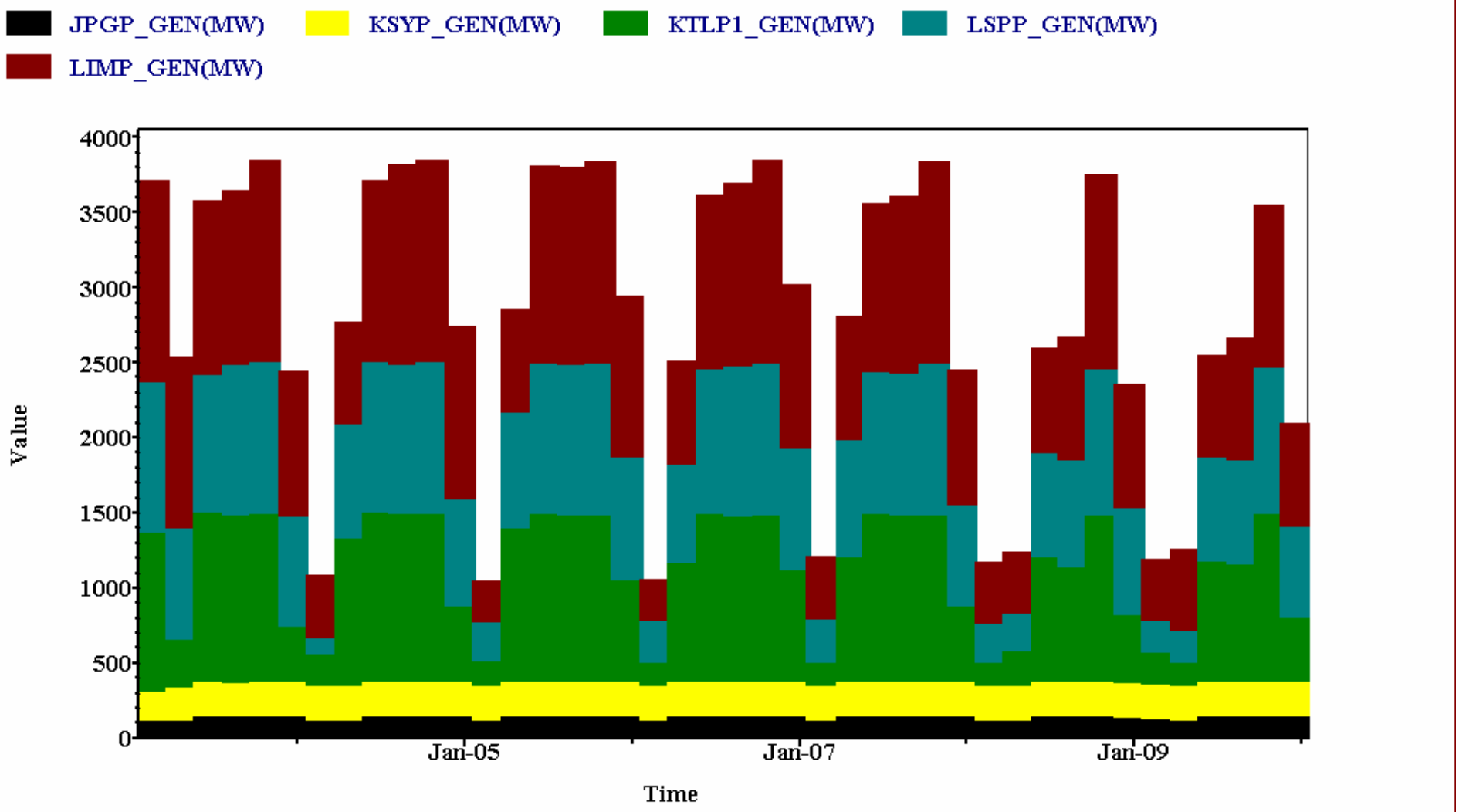
Short Term Generation Scheduler - C:\Work\PO2011010301.SCH - [Chart - Nelson Plant]

File Edit Status Schedule Display TableCharter Window Help

Nelson River Plants
Generation

Wednesday, November 09, 2005
Ref Time: Monday, January 03, 2011 01:00:00



OPT Complete | SIM Complete | Sun Jan 02 2011 24:00 (Static) | 10:39 AM

Short Term Generation Scheduler - C:\Work\PO2011010301.SCH - [Chart - Net Transactions]

File Edit Status Schedule Display TableCharter Window Help

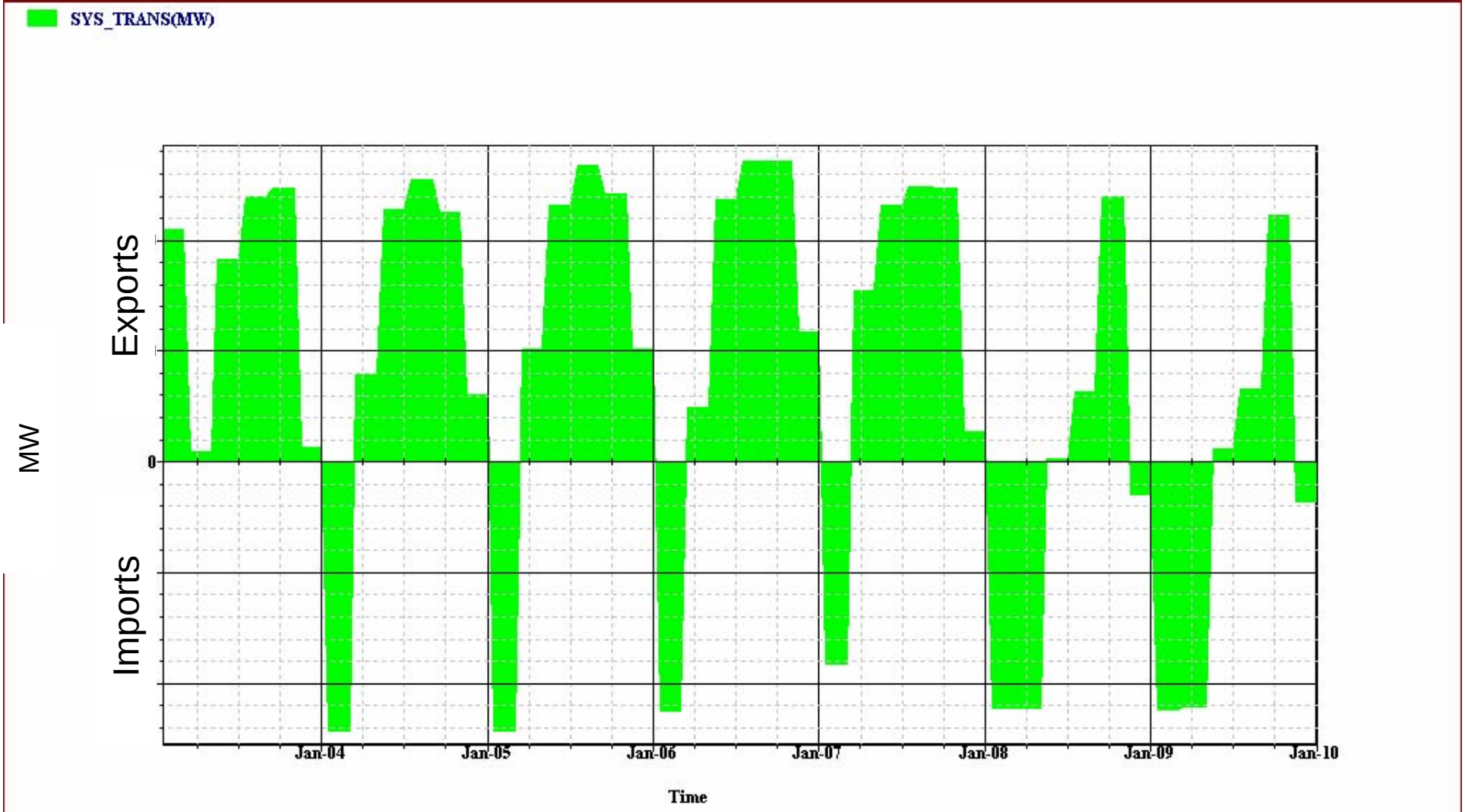
Net Transactions

System

From Mon Jan 03 2011 01:00 to Sun Jan 09 2011 24:00

Wednesday, November 09, 2005

Ref Time: Monday, January 03, 2011 01:00:00



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Using the Short Term Model for Wind Hydro Integration

- ⇨ Can model wind and capture the effects of the day-to-day and week-to-week wind variability and uncertainty on reservoir operations.
- ⇨ Can monitor reservoir reshaping
- ⇨ Can redistribute wind energy to peak hours and/or offset off peak imports because it models market opportunity.
- ⇨ Can model multi-reservoir systems and their hydraulic considerations.

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Modelling Wind Hydro Integration

- System Related (Manitoba Hydro)
  - Uncontrolled Lakes and channels
  - Long river reaches and lag times
  - Ice conditions in winter
- Wind Related
  - Uncertainty in wind forecasts
  - Variability in wind energy delivery

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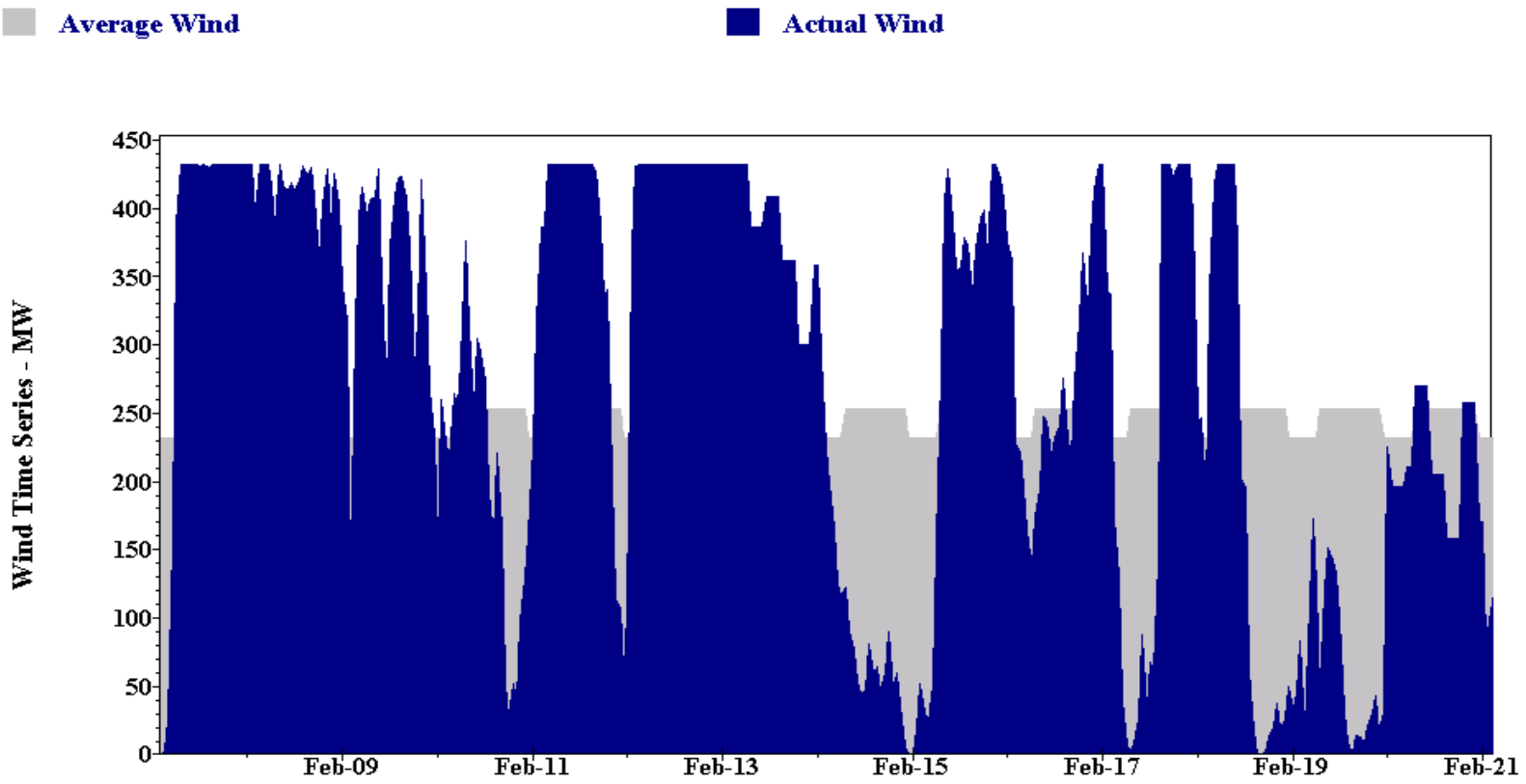
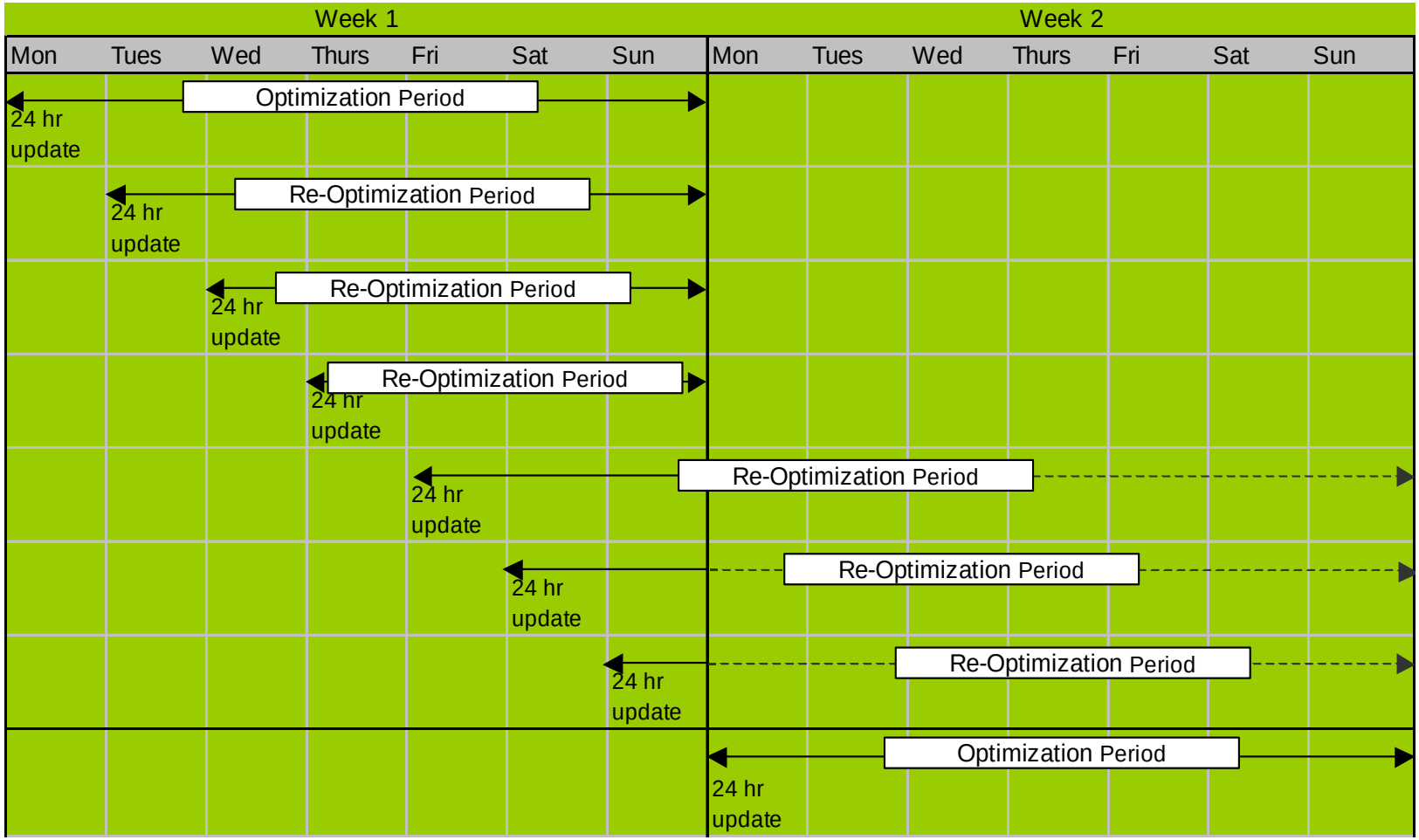
Wind Uncertainty and Variability



- Reasonably accurate for the first 24 hrs – High variability from hour to hour

Wind Updating and Optimization



System Transactions

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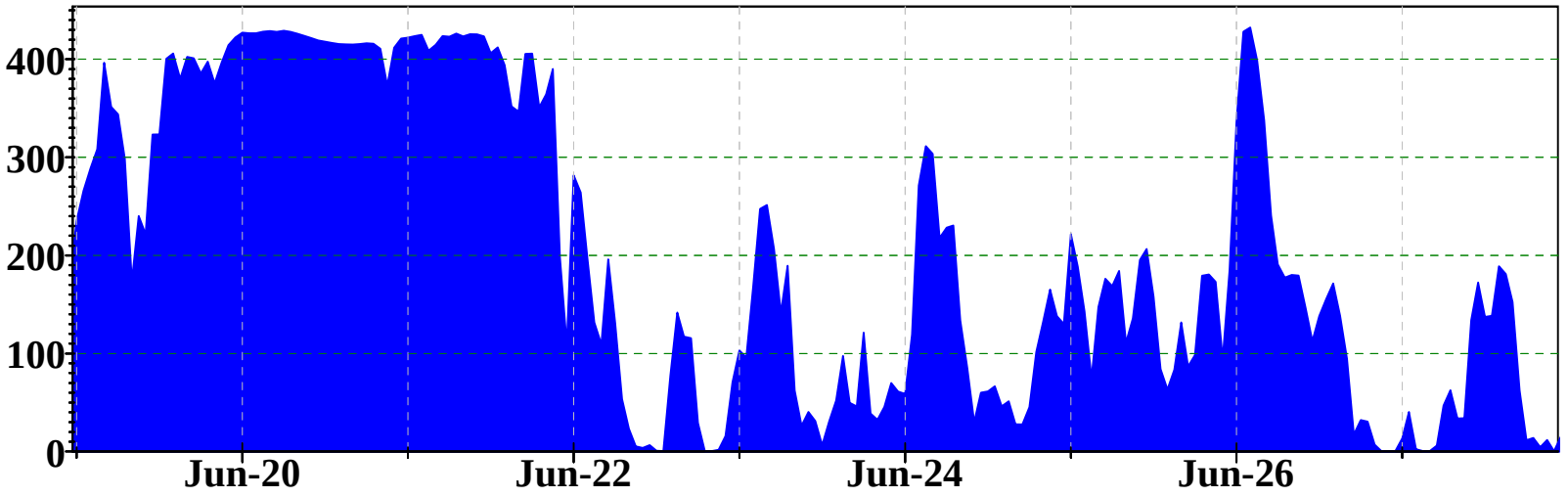
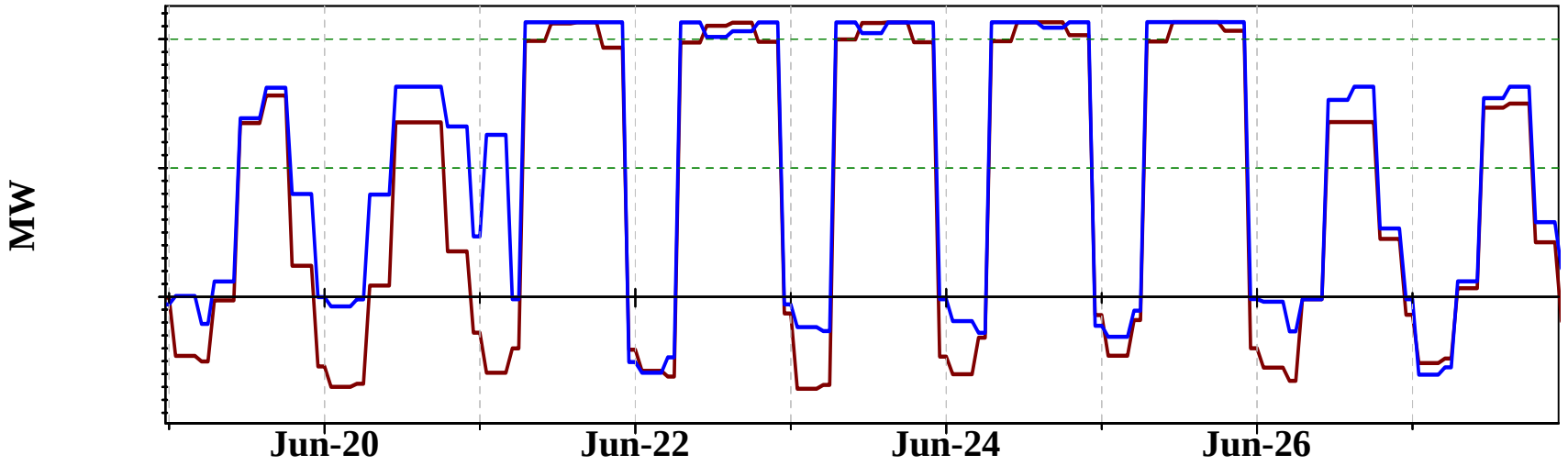
UserID: DHurdowar-Castro

Wind Time Series



Base No Wind

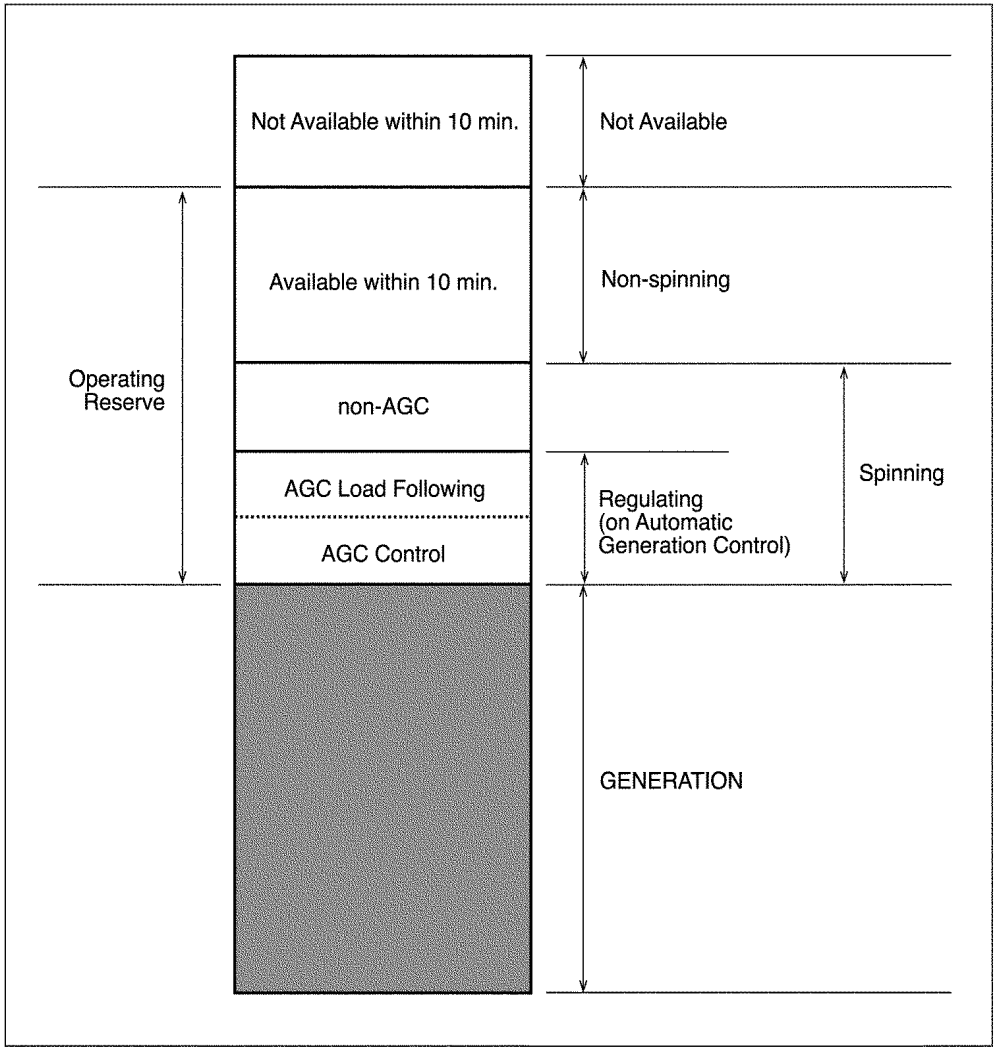
500 MW Wind Capacity



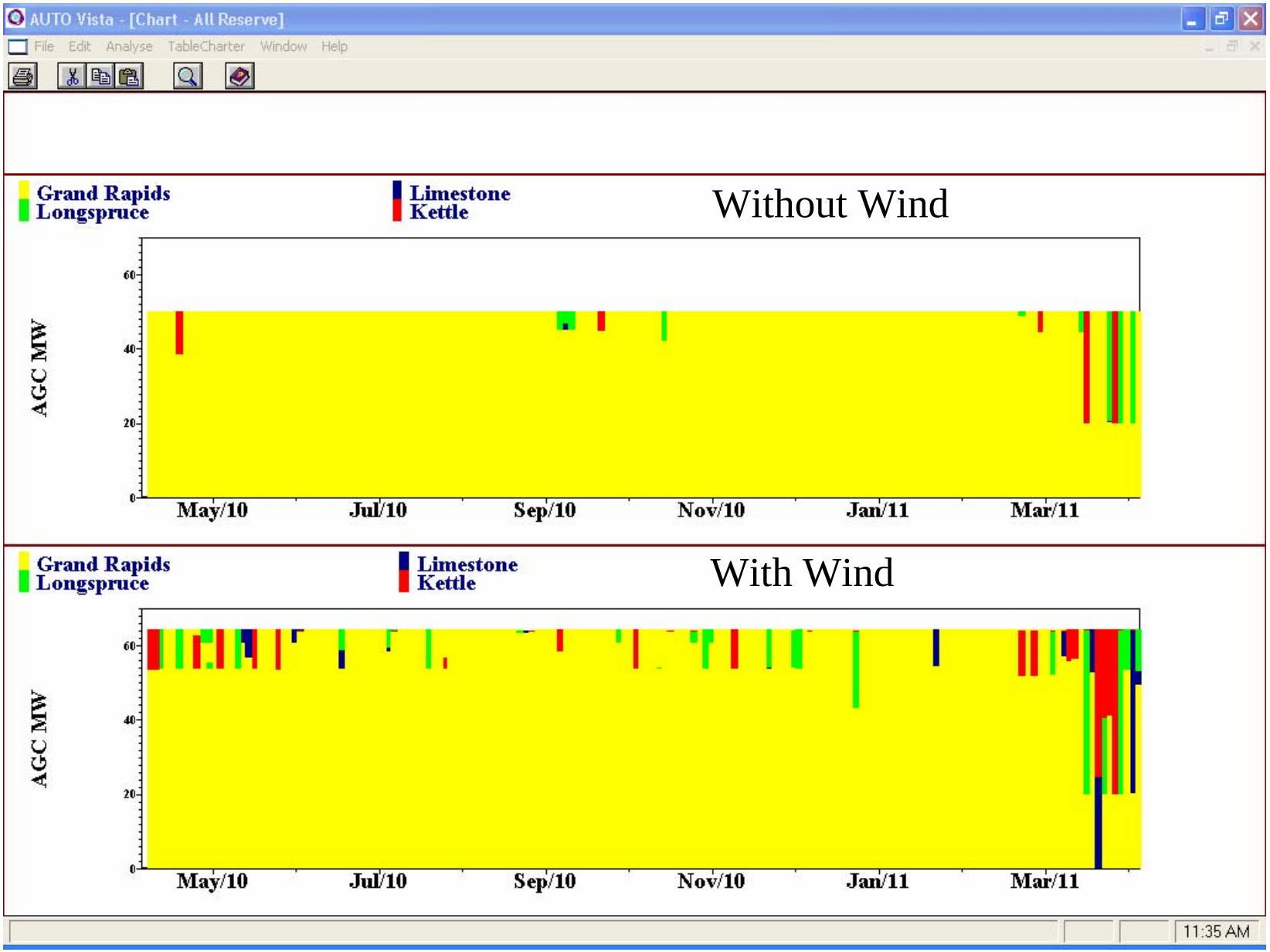
Modelling Reserves

Can model both the variability and uncertainty of wind and the associated reshaping of operations.

Need to include the additional reserve requirement

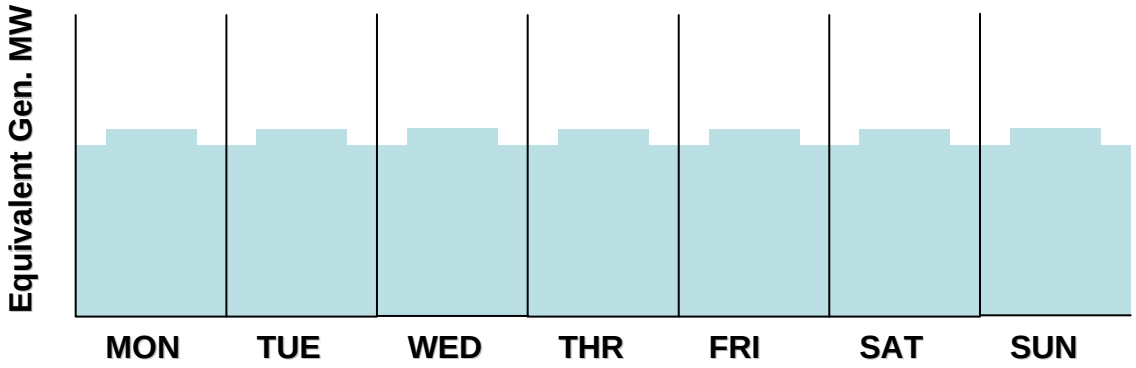


AGC Reserve Requirement

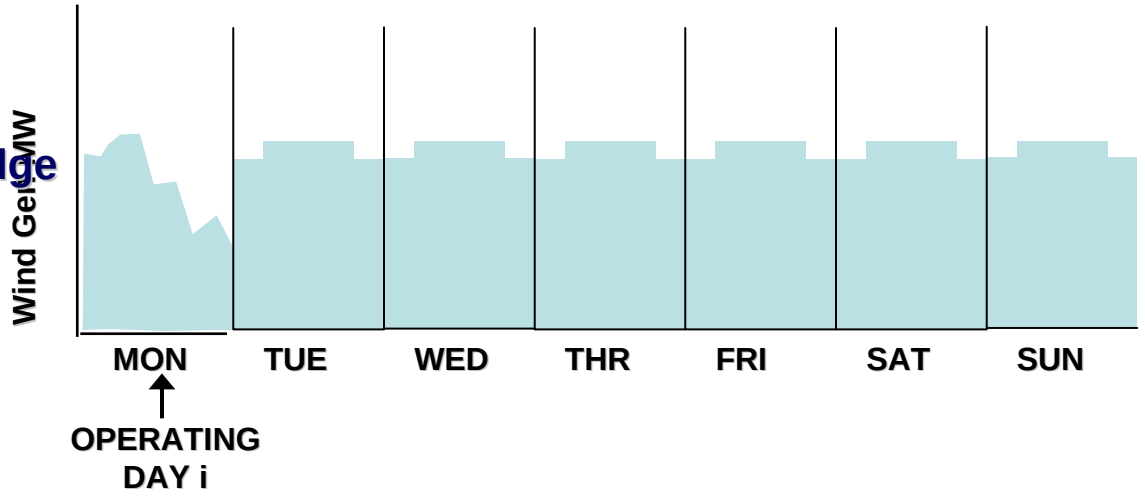


Modelling Short Term Wind Uncertainty and Variability

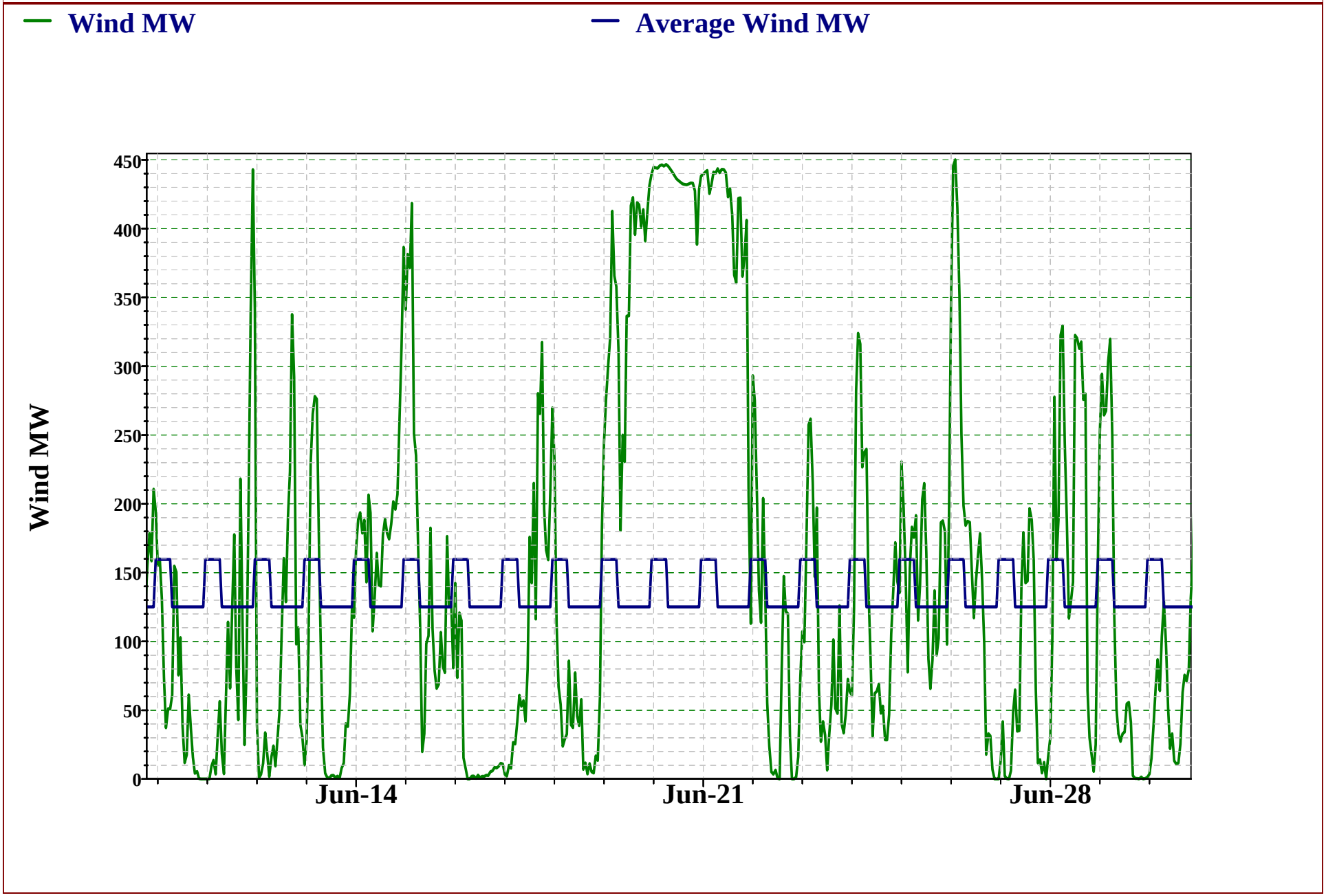
CASE 1
- **Monthly average energy**
- **No added reserves**



CASE 2
- **Perfect foreknowledge on operating day**
- **Assume monthly average for subsequent days**
- **Advance daily**
- **Added reserves**



Average and Actual Wind Time Series



AUTO Vista - [Chart - Presentation]

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Net Transactions

Graphs

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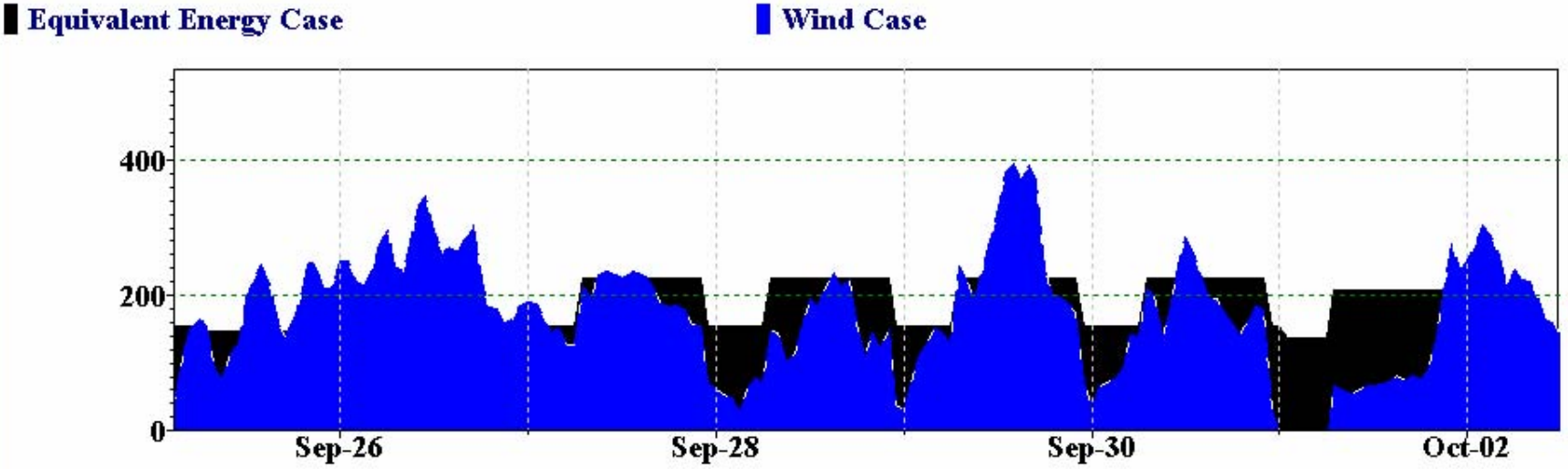
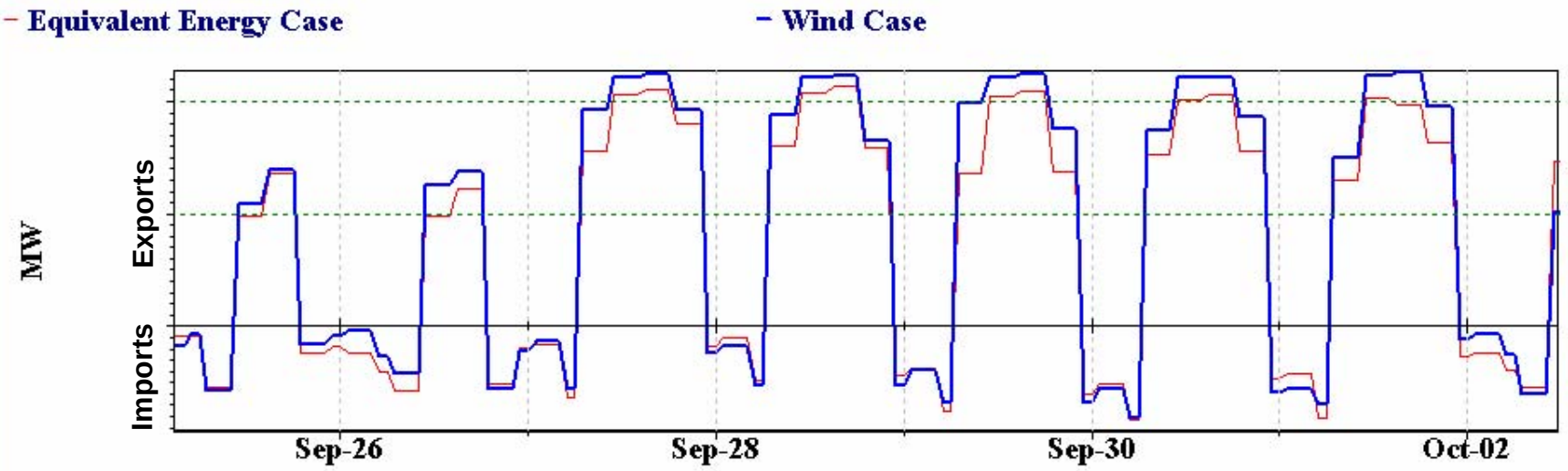
From Fri Jan 01 2010 01:00 to Sun Jan 01 2012 01:00





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AUTO Vista - [Chart - Present Tie Line]

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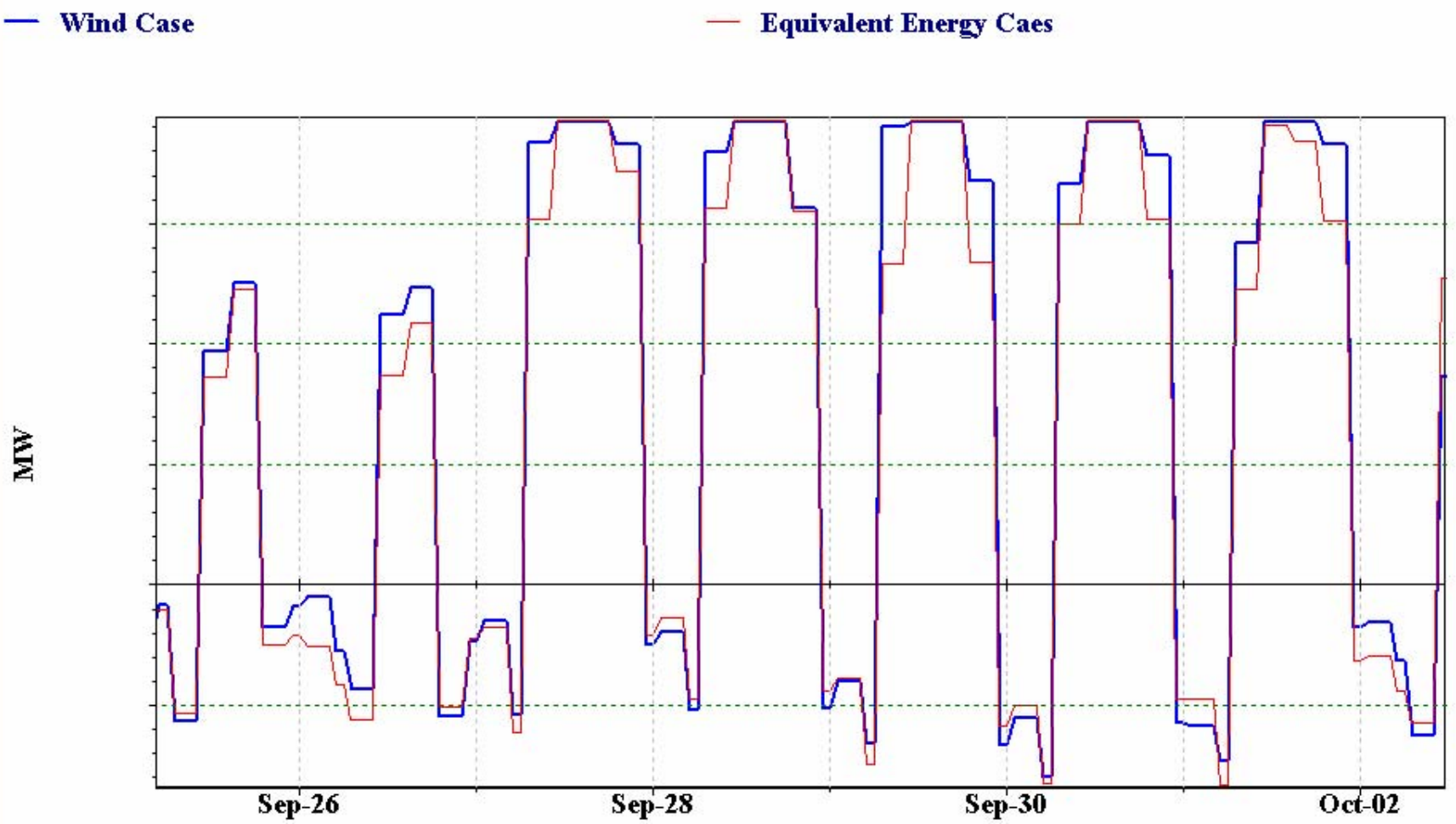
Tie Line Activity

Activity

Ref Time: Monday, April 05, 2010 01:00:00

From Fri Jan 01 2010 01:00 to Sun Jan 01 2012 01:00 for tieLOAD@CNT_USA(MW)



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Final Points

- Using MOST (ST *Vista*)
  - Able to determine the incremental cost associated with a wind supply source (reserves + variability + uncertainty)
  - View the change in Hydro operations to accommodate wind (transactions, reservoir operations, tie-line activity, reserves)

- Further we can
  - Assess different levels of wind capacity
  - Assess the impacts to the transmission system
  - Determine a point of saturation, at what point will the system be saturated and spill is just directly traded off with wind energy.

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